ENTOMOLOGICAL
SOCIETY OF
BRITISH COLUMBIA

PROCEEDINGS

OF THE

ENTOMOLOGICAL SOCIETY

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(INCORPORATED)

1932

NUMBER TWENTY-NINE

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PROCEEDINGS

of the

Entomological Society of British Columbia

The 31st Annual Meeting was held on Saturday, March 5th, 1932, in the "Daily Province" Board Room, Vancouver, B.C.

The President, J. W. Winson, occupied the chair and the following members were present:—Messrs. Buckell, Cianci, Cowan, Downes, Eastham, Finley, Glendenning, Glover, Graham, Gregson, Hearle, G. Hopping, Lyne, Marmont, Menzies, Sherman, Spencer.

The minutes of the last meeting together with the financial statement were read and adopted. Two new members were elected, Messrs. G. Hopping and T. P. O. Menzies.

The following papers were presented and provoked interesting discussion:—

Presidential Address ..... J. W. Winson
Notes on the black flies of British Columbia ..... E. Hearle
Insect parasites of coast deer ..... I. McTaggart-Cowan
Book lice infesting British Columbia homes ..... K. Graham
Notes on **Dyslobus decoratus** ..... W. Downes
Enigmas in the biology of the Schizoneurinae ..... A. D. Heriot
Report of the entomology of the Forbidden Plateau ..... J. D. Gregson
Further notes on **Ryncocephalus sackeni** ..... G. J. Spencer
Some forest insect problems in B.C. ..... G. Hopping
Epidapus scabies, a greenhouse pest in B.C. ..... G. J. Spencer
Notes on **Aphodius pardalis** in lawns ..... W. Downes
A cheap method of taking enlarged photographs of small objects ..... G. J. Spencer

The election of officers resulted as follows:—

Honorary President—J. B. Munro.

President—J. W. Winson.

Vice-President for Coast—G. J. Spencer.

Vice-President for Interior—E. R. Buckell.

Advisory Board—Messrs. Downes, Larnder, Eastham, Lyne, Marmont and Whittaker.

Honorary Secretary-treasurer—R. Glendenning, Agassiz, B.C.

Honorary Auditor—J. W. Eastham.

During the meeting, the President spoke to Mr. Whittaker on the telephone, expressing the regret of those present at his inability to attend.

The meeting adjourned at 5 p.m.

REPORT OF THE SECRETARY-TREASURER, 1931

I beg to submit the following details of the activities of this Society for the past year.

FINANCES

The financial statement shows a credit balance of $39.72. While this is satisfactory it is quite inadequate to continue the publication of our Proceedings unless the usual Provincial Government grant is again forthcoming.

PROCEEDINGS

Number 28 of our series was published during the year through the kindness of the Provincial authorities. The cost was kept down to $139.

MEMBERSHIP

The membership again shows a small increase and now stands at 45, most of whom are in good standing.

LIBRARY

The usual number of exchanges has been added to our library and a further catalogue should be issued.

ADVISORY BOARD

No meeting of the Advisory Board was held during the year, any necessary business being performed by correspondence or telephone.

R. GLENDENNING,
Hon. Secretary-treasurer.

FINANCIAL STATEMENT, 1931

Receipts		Expenditures	
Balance forward	$10.90	Postages	$15.00
Subscriptions	61.00	Printing Proc. No. 28	139.38
Bank Interest	2.25	Freight on Proc	3.95
Prov. Govt. cheque	150.00	Sub. "Pan-Pac. Ent."	2.00
		Ont. Soc. dues	23.00
		Sundries	1.10
		Balance in bank less outstanding cheque	39.72
	$224.15		$224.15

Certified correct,
R. GLENDENNING,
Hon. Secretary-treasurer.

Audited and found correct,
J. W. EASTHAM, Honorary Auditor.

THE BLACKFLIES OF BRITISH COLUMBIA (SIMULIIDAE, DIPTERA)

ERIC HEARLE, DOMINION ENTOMOLOGICAL LABORATORY, KAMLOOPS, B.C.

General.

In a paper which the writer prepared for the 1929 meeting of the Society, it was stated that an investigation of the blackfly fauna of British Columbia was being undertaken, and that this would be reported on at a later date. We are now in a position to give at least a preliminary list of this rather neglected but most important family of blood-sucking flies. During the past winter some 2,000 adult specimens have been worked over, the great proportion of these consisting of reared material from a number of streams in the province. An even more extensive accumulation of larvae and pupae await identification; they consist of about 100 collectings from some seventy-five streams of various types. While most of our collecting has been in the dry belt in the Kamloops district, much material is also available from the Kootenay, Okanagan, Chilcotin and Coast districts, and Vancouver Island.

Eleven undescribed pupae and about the same number of undescribed larvae have been taken. Isolated rearings have definitely associated the respective adults with six of these. Pressure of work makes it impossible to deal in any detail with more than one of these at the present time, but this particular form has such unusual peculiarities that it is described herewith.

Although F. W. Edwards of the British Museum has indicated in a recent paper his opinion that the family consists of the single genus **Simulium** (with the possible exception of **Parasimulium)** and that the other divisions of various authors must sink to sub-generic rank; the writer is, in this paper, following the classification given in Dyar and Shannon, "The North American Two-winged Flies of the Family Simuliidae," since no opportunity has yet occurred for a careful perusal of the paper cited.

One of the most troublesome and most generally distributed species in the province is **Simulium venustum** Say, which is the main blackfly that attacks man. It breeds in moderately small streams, often with comparatively sluggish flow and containing much aquatic vegetation. **Simulium arcticum** Malloch and **Simulium vittatum** Zetterstedt are two other outstandingly abundant and generally distributed blackflies; both appear to prefer the larger animals, and the former is not known to attack man. **Simulium vittatum** Zetterstedt breeds in rather small streams, but **Simulium arcticum** Malloch develops in the larger rivers where suitable shallows and ripples occur. We have found it to be abundant in such streams as the Athabasca at Jasper and in the Okanagan river. There are strong indications that it breeds in parts of the Fraser and Thompson canyons. While the above three forms are widely distributed and occur under very diverse topographical conditions, certain other British Columbia species are restricted to rather high elevations, the two most noticeable among these being **Prosimulium fulvum** Coquillett, the common, red, mountain blackfly, and **Prosimulium novum** Dyar & Shannon; both of these attack man as well as horses and other large animals.

Concise List of Known British Columbia Species of Simuliidae to June, 1932

Prosimulium pleurale Malloch.
" **novum** Dyar & Shannon.
" **dicum** Dyar & Shannon.
" **dicentum** Dyar & Shannon.
" **fulvum** Coquillett.
" **hirtipes** Fries.
" **pancerastes** Dyar & Shannon.
Eusimulium aureum Fries.
" **mutatum permutatum** Dyar & Shannon.
" **clarum** Dyar & Shannon.
" **minus** Dyar & Shannon.
" **boreale** Malloch.
Simulium vittatum Zetterstedt.
" **kamloopsi**—new species.
" **decorum katmai** Dyar & Shannon.
" **virgatum canadensis**—new race.
" **hunteri** Malloch.
" **sayi** Dyar & Shannon.
" **arcticum** Malloch.
" **venustum** Say.

NOTES ON SPECIES

In the following notes only the main salient "recognition marks" are given for each species and no attempt is made to give more than a brief summary regarding distribution, early stages, breeding places, host preferences, etc. The writer has under preparation a more comprehensive paper dealing with the **Simuliidae** as they occur throughout Western Canada and these points will then be dealt with in considerable detail, together with descriptions of early stages and male and female genitalia. Dissections of the latter have been made in nearly all cases to verify identifications in the present paper. The bionomics of **Simulium virgatum** var. **canadensis** were briefly indicated in the author's paper published in No. 26 of the Proceedings (1929) and further observations are given in the case of this species to amplify our former notes.

Genus **Prosimulium** Roubaud

Species characterized by the entire length of the radius being setose, the radial sector having a long fork, the hind basitarsus not produced and no dorsal incision at the base of the second hind tarsus; this segment fairly long. All of the seven species occurring in the province are large to medium sized blackflies.

Prosimulium pleurale Malloch

This is a fairly long greyish species distinguished from all others of the genus by the three patches of hair on the pleura; the claws are bifid with a thumblike basal projection and the legs brownish yellow; the thoracic integument is uniformly dark brown and is clothed with rather coarse yellowish white scales.

Nothing is known of the early stages or breeding places. It does not appear to be particularly common in British Columbia and is represented in our collections only from the Kamloops, Nicola, Chilcotin and Lillooet districts. (In the latter place taken by E. R. Buckell and

M. Ruhmann). Malloch, and Dyar and Shannon record it from Kaslo, which is the type locality.

Prosimulium novum Dyar & Shannon

Medium sized black species with unicolorous dark mesonotum clothed with yellow scales; the black antennae are very distinctly nine-jointed instead of eleven as in all other species; claws simple.

The preferred type of stream, early stages and males are unknown, and although a search was made for larvae and pupae in a number of high mountain streams no specimens that could be identified with this have been located. It is the dominant blackfly during July in the mountains in the vicinity of Kamloops and adjoining the North Thompson valley. Our specimens were mainly taken at from 4,000 to 5,000 feet. We have specimens from the Kootenays (taken by C. B. Garrett) and Dyar and Shannon record it from Kaslo. It is sometimes quite a serious pest to horses on high mountain sheep ranges and will also attack man.

Cold creek, Kamloops, B.C. A small permanent cool stream that is very well aerated. **Eusimulium boreale, Prosimulium dicentum, Simulium virgatum canadensis** and **Simulium sayi** bred from this stream in very considerable numbers. A few **Prosimulium fulvum** also reared here.

Prosimulium dicum Dyar & Shannon

No specimens came to hand during extensive collecting over four years. According to Dyar and Shannon this is a medium sized species, dark in colour with pale pilosity; the legs being dark or in part brownish yellow; the antennae are entirely dark and the stem vein is black pilose; claws simple.

Early stages and male unknown. Dyar and Shannon record this apparently very rare species from Prince Rupert.

Prosimulium dicentum Dyar & Shannon

A dark robust species of medium size; mesonotum unicolorous brownish black, unusually densely clothed with fairly long yellow scales so that little of the integument remains visible; legs with tarsi black, but femora and tibiae almost entirely yellowish; claws simple; stem vein pale pilose; antennae entirely black.

The group in which **dicentum** and **hirtipes** belong embraces several species which superficially resemble each other very closely and are hard to separate in dried specimens. We have large series of the hitherto unknown male, pupa and larva, the pupa being of the same type as **hirtipes** and **magnum,** no definite case being made. Each breathing organ consists of upwards of 100 very fine filaments. Male genitalia rather like **exigens,** clasper with three terminal claws. The preferred breeding places appear to be fairly small streams with stony shallows. This was one of the commonest species in rearings from a number of streams in the dry belt but very few were obtained in the numerous collections made on the wing or from animals.

Prosimulium fulvum Coquillett

The uniform orange yellow colour of this large mountain species is so conspicuous that it cannot be confused with any other; the tarsal claws are simple.

This is a very widely distributed and common blackfly in the mountains of British Columbia. It occurs in the mountains of the lower mainland; is one of the most abundant species at elevations of from 4,000 to 5,000 feet in the Kamloops district and North Thompson valley, and in the Rocky Mountains in the easterly limits of the province. E. R. Buckell has collected large series from the Barkerville district, and Dyar and Shannon record it from the Kootenays; the former has also taken specimens at Prince Rupert. The early stages are unknown, although the writer has reared this species on several occasions from a small, shallow, cold stream in the Kamloops district. The pupae were so rare here that in a miscellaneous lot of more than 1,000 pupae worked over nothing that could be this species was located. It will attack both man and the larger animals, but appears to prefer the latter; horses often suffer considerably from it on high mountain sheep ranges.

Prosimulium hirtipes Fries

A fairly large dark species superficially resembling **dicentum;** the mesonotum is dull black and fairly densely clothed with yellowish scales, these, however, not so closely placed as in **dicentum;** legs dark yellowish brown; antennae with basal two joints pale; stem vein pale pilose; claws simple.

No specimens that can be definitely placed as this species are present in British Columbia material, but we have specimens from Banff (C. B. Garrett) that obviously belong here. Malloch records it from Kaslo and Laggan. Dyar and Shannon indicate that this species does not occur west of the Mississippi, but is replaced in western North America by closely allied forms. The early stages have been described and adults are stated to occur early in the year. There is little definite information regarding their biting habits but apparently they occasionally attack man and livestock.

Prosimulium pancerastes Dyar & Shannon

This species is stated by Dyar and Shannon to be almost indistinguishable from **hirtipes** in the female but to show marked differences in male genitalia. It is possible that the specimens recorded from British Columbia by Malloch as **hirtipes** may belong here, and it is evident that this particularly closely allied group of species is in need of further detailed studies with rearings from isolated pupae. **Prosimulium hirtipes** has a very wide distribution in Europe and America but the early stages

are unfortunately not known from the former. Dyar and Shannon record **pancerastes** from the following points in British Columbia; Prince Rupert, Kaslo and Laggan. It appears to be fairly common.

Genus **Eusimulium** Roubaud

Species falling in this genus have the radius setose for its entire length but the radial sector is simple and not forked as in **Prosimulium.** The hind basitarsus may be produced apically or not, and a dorsal incision on the second hind tarsal joint may be present or absent. Only five species have so far been definitely identified from British Columbia.

Eusimulium aureum Fries

Rather small species characterized by the somewhat coarse bright golden scales that densely clothe the mesonotum; this species has a most unusual characteristic in that the postnotum bears a small number of golden scales; legs are bi-coloured with yellow predominating; fore coxae yellow; basal two joints of antennae yellow in strong contrast to remainder; claws bifid with strong thumblike basal projection.

This is a rare species and only a few specimens have come to hand during four years collecting in British Columbia; they are all from the Kamloops district and were reared out of four-filament pupae from small shallow permanent streams. It does not appear to be a blood-sucker and consequently is seldom collected.

Eusimulium mutatum permutatum Dyar & Shannon

Medium sized very dark brown species; mesonotum uniform dark brown with sparse scattering of pale fine scales; antennae brown and cylindrical, not tapered; very prominent apical projection on hind basitarsus, but no incision on second hind tarsus; spurs on hind tibiae unusually long; claws simple.

This appears to be very rare in British Columbia since there is only a single representative among nearly 2,000 specimens examined. This was taken by T. K. Moilliet and R. Turner from a brush plateau at 4,000 feet elevation in the North Thompson district. Little is known of the blood-sucking habits but this particular specimen was taken on a horse. Malloch, and Dyar and Shannon record this species from Kaslo and Prince Rupert, the latter place being the type locality for the western race **permutatum.**

Eusimulium clarum Dyar & Shannon

This species is rather similar in appearance to **minus** and to the eastern **johannseni;** in fact **clarum** might better be considered as a western variety of the last-named species, especially since the pupae are similar with but four respiratory filaments on each side. Male and female genitalia, however, show distinct differences in the two forms. **Eu. clarum** is a small blue-grey species with dark legs: the dark grey mesonotum, when denuded, has two rather broad darker central vittae narrowly divided, vestiture much as in **minus,** pale and slightly iridescent; dorsal plates on abdomen reduced; tarsal claws bifid with strong thumblike basal tooth; hind basi-tarsus produced and dorsal incision on second tarsal segment; stem vein pale pilose.

The breeding places were found to be small to moderate sized, swift flowing, shallow streams with stony ripples; pupae often being attached to trailing submerged grass. Specimens were taken only in the dry belt in the Kamloops, Nicola and Okanagan districts, and are prob-

ably restricted to the drier parts of the province. Little is known of the blood-sucking habits, but on one occasion this species was found feeding on the head of a young long-eared owl **(Asio wilsonianus).**

A most unusual migration of these blackflies was observed in the town of Kamloops during late June, 1930, when very large numbers were noted on house screens in the centre of the town. Conditions were very dry, and, with the exception of the large Thompson river, all streams within a radius of eight miles had completely dried up at this time.

Eusimulium minus Dyar & Shannon

A small dark species very similar to **johannseni** and **clarum;** general colour dark grey to black; mesonotum black, without noticeable markings, fairly closely covered with short, pale, somewhat iridescent scales; dorsal abdominal plates black, sparsely haired, less reduced than in **clarum;** legs dark, freshly emerged specimens show paler areas centrally on the femora and tibiae, joints dark; tarsal claws bifid with strong thumblike basal tooth; hind basi-tarsus produced apically and dorsal incision on second tarsal join;; stem vein black pilose.

Paul creek, Kamloops, near source. Semi-permanent small stream with many stony ripples. **Simulium venustum** and **S. vittatum** breed here in great numbers. A few **S. decorum katmai** and **Eu. aureum** also reared from this stream.

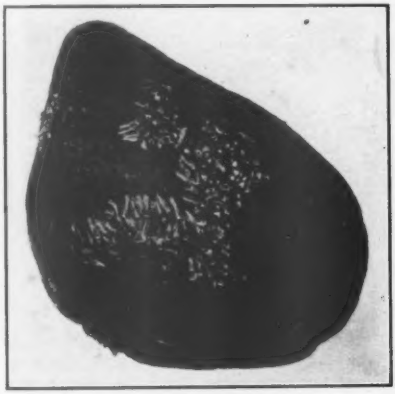
The hitherto unknown male is black without thoracic ornamentation, the mesonotum being clothed with rather long pale to golden scales. Male genitalia rather like that of **clarum,** but with bridge on side piece narrower; drawn out angle at tip of clasper more acute; adminiculum with strong, dark, basal prongs; arms not toothed as in **clarum** but broad and rounded, side plates pointed and strongly chitinized.

Series of adults of both sexes were reared from a shallow, sluggish stream flowing from a beaver dam at Lone Butte, Cariboo district. Pupae, which were mainly attached to trailing aquatic vegetation, have eight filaments on each side. Three filaments arise from one stem, one is single and there are two paired filaments. Pupal case rather coarsely woven with irregularly sized openings towards anterior end, these not in form of regular wide "lattice work" as in **arcticum.** Nothing is known of the blood-sucking habits.

Eusimulium boreale Malloch

A fairly large greyish species; mesonotum with long fine whitish scales; grey black integument ornamented with two central brown vittae expanding club-shaped posteriorly, broad lateral vittae on each side of same colour; scutellum with very long dense white pile; abdominal pile pale and not very dense dorsally, but very closely placed laterally and ventrally; extremely long and dense on abdominal scale; outstanding characteristic a patch of white hair anteriorly below the lateral margin of scutum on membraneous part of mesopleura; stem vein pale pilose, (males black pilose), antennae and legs wholly dark; basitarsus not produced, no incision on second tarsal segment; claws bifid, produced thumblike at base. Male genitalia will be described in a later paper.

The description above is given rather fully since this species has previously been meagrely represented in collections by less than half a dozen poor specimens. The thoracic ornamentation of the female has apparently been previously overlooked. This species is one of the commonest in the Kamloops district and large series of both sexes have been reared from a number of streams, these mainly small and rather slow-flowing over rocks; **dicentum** is usually found with it. The early



Blackfly pupae on stone from Meadow creek near Kamloops, B.C. **Prosimulium dicentum** in mixed colonies with **Eusimulium boreale**—latter with boot shaped case.

stages have been hitherto unknown and the pupae have breathing filaments of a rather peculiar character. Each breathing organ has five stout rootlike tubes of varying sizes spread fingerwise and arising from a bulbous base, two tubes paired; from all five tubes are a very large number (approximately 200 in all) short hairlike white filaments of about equal size and mainly simple. Case pale grey, of smooth texture and boot-shaped. It is doubtful if this species is ever very troublesome as a blood-sucker since only a single specimen was taken on the wing, in spite of the fact that it was the dominant species in a number of dry belt streams examined.

Genus **Simulium** Latrielle

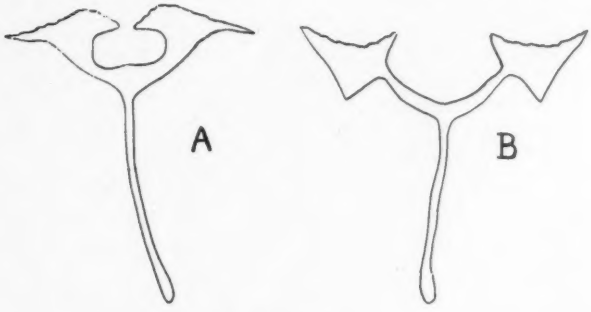
In this genus the radial sector is simple as in **Eusimulium** but instead of being setose the entire length, is bare of setae from the stem

vein to base of radial sector; hind basitarsus produced lappet-like apically and second hind tarsus with distinct dorsal incision. Eight species have been recognized in the British Columbia fauna.

Simulium vittatum Zetterstedt

A medium sized grey and black species readily recognizable by the strikingly ornamented mesonotum and series of three rows of large black spots contrasting strongly with the grey abdomen; mesonotum five-striped as follows: central linear black stripe often infuscated broadly at sides, dorso-lateral stripes curved and dilated at each end, very broad markings to lateral edges of mesonotum; mesonotal scales, small, scattered and pale; legs contrastingly bi-coloured; stem vein pale pilose; antennae brownish grey, two basal joints yellowish; claws simple.

In most of the males reared in isolation from typical sixteen-filament pupae there are no distinct silvery vittae on the velvety black thorax, although in a few specimens there is an indication of such ornamentation. There is probably no other blackfly in North America with so wide a distribution and it is also reported as being common in various parts of Europe. It is a very troublesome pest of the larger domestic



FEMALE GENITAL FORK
A. **Simulium kamloopsi** new species.
B. **Simulium vittatum** Zett. (drawing adapted from Dyar and Shannon)

animals, the insides of the ears being the preferred place for feeding, although it will attack other parts as well. Man is by no means exempt from its attacks but where large animals are available it appears to prefer them. The breeding places are small to moderate sized streams with stony ripples, often containing much trailing aquatic vegetation on which large numbers of pupae may be attached. Our specimens are mainly from the dry interior from the Kamloops district, the southern Okanagan and Cariboo district, but it is undoubtedly fairly generally distributed throughout the province. Dyar and Shannon record it from northern British Columbia at Taku in the Cassiar district.

Simulium kamloopsi—new species

Colouration of adult female as in **vittatum,** but uniformly smaller and genital fork different, arms not widely separated but inner tri-

angular projections almost meeting, plates quadrately and broadly expanding from near base, outer edge irregular, tapering on each side to sharp point; cerci and anal lobes as in **vittatum.**

Male mesonotum velvety black with two very broad and distinct silvery stripes extending from anterior edge to well back on mesonotum, tapering posteriorly, each stripe expanding laterally L-shaped at anterior marking of mesonotum; broad central area dividing stripes about equal to width of stripes at middle of mesonotum; male genitalia much as in **vittatum,** clasper with three stout terminal teeth.

Pupae with each respiratory organ of ten filaments, not sixteen as in **vittatum.** No variation noted in large series examined.

Type locality—Kamloops, B.C.

Holotype —Male, No. 3444, Canadian National Collection, Ottawa.

Allotype —Female, Canadian National Collection, Ottawa.

Paratypes —70 reared females and 60 reared males distributed in Canadian National Collection, U.S. National Museum, British Museum and author's collection.

This species was 85% dominant in Peterson creek, Kamloops, at the end of August, 1928 (See p. 51, B.C. Entomological Society Proceedings No. 26, 1929). At this time about 20% had reached the pupal stage. A very few **Simulium virgatum canadensis** and **S. sayi** occurred with it, although the former species was dominant in this stream in the very early spring. Nothing is known of the blood-sucking habits.

Simulium decorum katmai Dyar & Shannon

Fairly large grey species with mesonotum unusually large and strongly arched, giving even more of a humped appearance than other species examined; mesonotum without distinct ornamentation but colour not uniform, centre brownish black shading into bluish pearlaceous on each side, two luteous brown patches laterally on each side of anterior margin; mesonotal scales brassy, very small, fine and evenly but rather sparsely distributed; long hairs of scutellum and pre-scutellar depression sparse, black; abdominal tergites wide, sub-shining, bluish grey, vestiture sparse, basal four segments black, opaque; legs bicoloured, mainly brownish yellow except at apical half of basitarsus and remaining tarsal segments, tip of femora and tibiae, fore tibiae with white pollinose patch, fore coxae yellow; claws simple; face opaque, grey; frons sub-opaque; antennae with basal two segments yellowish brown; stem vein pale pilose.

A rather full description is given of this species since previous descriptions are all too meagre. It appears to have a very wide distribution in North America but to be quite rare. About twenty specimens came to hand from British Columbia in four years; these were all from the Kamloops and Nicola districts. The early stages are still unknown although this species was originally described in 1848. Several specimens were reared from a mixed lot of pupae in June, 1930, from a small permanent stream with many rocky ripples, flowing through a well wooded gorge, but they occurred in such small proportions among **Simulium venustum** and **S. vittatum** that we were unable to associate the larvae and pupae.

Simulium virgatum canadensis—new race

Medium sized pale grey species with bicoloured legs; mesonotum with faint reddish tinge beneath grey surface pollen; ornamented with three distinct dark vittae, central one linear and very narrow, lateral ones broad, curved and dilated into pear-shaped spots anteriorly, giving a lyre-shaped pattern, mesonotal scales fine, yellow and closely and uniformly distributed; frons and face opaque with pale grey pollen, eyes deeply incised; legs with more yellow than typical **virgatum,** but similar to **S. virgatum chiapanense** Hoffmann; fore coxae yellow; fore tibiae with white pollinose area; all femora and tibiae yellow except for dark brown apices; mid tarsi with basal half of first segment yellow; hind tarsi with basal two-thirds of first segment yellow, second segment yellow on basal half; balance of all tarsal segments dark brown to black; claws with small sub-basal tooth; basal abdominal tergites brown black velvety, apical four slightly sub-shining but not so markedly as in **decorum katmai;** vestiture very sparse, black; stem vein dark pilose.

Shingle creek, Penticton, B.C., April, 1929. Rocks and boulders very heavily encrusted with larvae and pupae. Almost entirely **Simulium virgatum canadensis** and **S. arcticum,** latter less abundant.

Male genitalia show distinct differences from the typical **virgatum** and the female genitalia are different from both **virgatum** proper and the race **chiapanense.** Differences in the male are as follow: inner angle of side piece broadly produced, cone-shaped, instead of outer angle as in **virgatum;** chitin not absent on inside as indicated in Dyar and Shannon illustration; clasper much more slender with small lobe on inner side at base; has similar terminal tooth; other parts very similar. Female genital rod with forks more widely spread, thickening of handle of plate rather more pronounced than in **virgatum** but not nearly so spatulate as in **chiapanense;** tips of forks not pointed, spear-shaped but rounded and swollen with small sub-apical lobe. The exact status of this form can hardly be decided until the early stages of **virgatum** and **chiapanense** have been found and recorded; for the present it is probably best to consider it as a new race rather than a distinct species.

S. virgatum canadensis is very widely distributed in British Columbia and we have taken it on Vancouver Island, throughout the dry interior in the Kamloops district and Okanagan and in the Kootenays. Although it is the dominant species at times in many small permanent and semi-permanent streams, comparatively few adults were taken biting and while it will attack the larger domestic animals it does not appear to attack man to any extent. In the paper on this species in the 1929 Proceedings of the Society, tentative notes were given on the bionomics as observed during the one year, 1928. Additional observations make it necessary to amend these somewhat since there is now evidence that several broods occur from the early spring to the autumn.

On June 1, 1930, pupae were very abundant in a small permanent stream near Kamloops, only a very small proportion had emerged by this date but heavy emergence occurred between June 8 and 16.

On August 3, 1931, another permanent stream, larger than the above and running swiftly over small boulders, contained great numbers of larvae and pupae of **virgatum canadensis** with practically no other species present. Some emergence of adults occurred here on August 6 but the main emergence would take place from mid to late August.

Another fairly large permanent stream with many ripples over small boulders examined on September 1, 1931, was found to contain only this species; a fairly large proportion were in the pupal stage. Emergence was noted on September 2 and considerable emergence occurred in laboratory rearing cages to September 11. In the stream it undoubtedly emerged in large numbers to late September.

Type locality of race **canadensis**—Kamloops, B.C.

Holotype —Male, No. 3454, Canadian National Collection, Ottawa.

Allotypes —Female, Canadian National Collection, Ottawa.

Paratypes—70 reared females and 40 reared males distributed in Canadian National Collection, U.S. National Museum and author's collection.

Simulium hunteri Malloch

This belongs to the **virgatum** group but is slightly larger and darker than the last species; the dark vittae on the mesonotum are of much the same appearance but the vestiture of this part is coarser and the scales are larger; frons shining and face sub-shining; fore coxae yellow; legs bicoloured; claws as in **virgatum canadensis;** fore tibiae with similar pollinose patch; apical four abdominal segments shining, black; stem vein dark pilose.

This species is not particularly common but has a fairly wide distribution in British Columbia. We have taken it in the Kamloops district, the Kootenays and at 4,000 feet elevation near Vancouver. It has been recorded by Malloch, and Dyar and Shannon from the Kootenays at Ainsworth, from the Cassiar at Glenora and Dyar has taken it in the Skeena district at Kwinitsa and also records it from Laggan. It attacks horses, cattle and man freely. Nothing is known of the breeding places, early stages or male.

Simulium sayi Dyar & Shannon

This is the third representative of the **virgatum** group and is about the same size as that species but is even darker than **hunteri;** the fore coxae differ from either of the last two species in being dark and there

is no white pollinose patch on the tibiae; same type of mesonotum ornamentation but vestiture not so coarse as **hunteri** or as fine as **virgatum canadensis;** frons and face opaque, grey; legs with black predominating; claws with small sub-basal tooth; abdomen with colouration similar to **hunteri;** stem vein dark pilose.

This species has previously been recorded only from Colorado and the early stages and male have hitherto been unknown. In the male genitalia the side piece is strongly shouldered as in **virgatum canadensis** and the clasper is somewhat similar in shape but with a moderately long, slender terminal tooth. Specimens were reared from several small streams in the Kamloops district—in one stream pupae were extremely scarce among various other species in June, but were dominant in September, 1930. In another stream in 1928 this species was dominant in July. The breathing organs consist of eleven filaments on each side, these three and four branched from three main basal stems. The pupal case has a fairly long pointed visor-like projection forward. Horses and cattle are attacked.

Okanagan river at Okanagan falls, B.C. Type of rocky ripples responsible for great numbers of blackflies. Larvae and pupae of **Simulium arcticum** abundant. Freshly emerged adults noted in April.

Simulium arcticum Malloch

Small to medium sized dark species with markedly bicoloured legs; mesonotal pilosity brassy and fairly long and well distributed; anterior mesonotum with large lateral pollinose areas; apical four abdominal segments shining, remainder velvety black; frons shining; face opaque; stem vien pale pilose; fore coxae yellow; fore tibae with white pollinose area; claws with small sub-basal tooth.

This is one of the most widely distributed and abundant species in western Canada, and one of considerable economic importance owing to its serious attacks on livestock, death sometimes being caused. It is annoying to man from its habit of flying into the face, but its blood-sucking appears to be restricted to the larger animals. The preferred breeding places are large rivers at points where rocks and boulders

form shallow ripples; it also occurs, however, in smaller permanent streams. The pupae have twelve filaments on each side and cases with characteristic large "lattice work" openings anteriorly. They often encrust rocks in very great numbers. Our specimens are mainly from the Kamloops district, North Thompson valley, Okanagan valley and Fraser and Thompson canyons. The type locality is Kaslo, and Malloch also records it from Bear lake. Additional records given by Dyar and Shannon are Lake Atlin, Kokanee Mountain, Lillooet and Hazelton.

Simulium venustum Say.

As in the case of **arcticum,** rather variable in size and colouring; blackish with markedly bicoloured legs; mesonotum dark, sub-shining; vestiture not as abundant as in **arcticum,** scales very fine and pale, too scanty to obscure dark integument; abdominal colouration much as in **arcticum;** frons shining, face opaque; stem vein pale pilose in some, apparently dark in others; fore coxae yellow; white pollinose patch on tibiae; claws simple.

Campbell creek near Kamloops, B.C., a slow-flowing, winding stream with much trailing aquatic vegetation. **Simulium venustum** here in great numbers in July; in early June larvae and pupae mainly **Eu. boreale and Pro. dicentum.**

Few Canadian blackflies have a wider distribution or are as abundant as this species, which is almost always the main culprit when fishermen and campers are tormented by swarms of these pests. Comparatively few Canadian species are definitely known to attack man sufficiently to be noticeably troublesome, but this species more than makes up for any hesitancy on the part of the others. It does not appear to have very marked host preferences but will readily attack most animals and is even a serious pest to birds. Very large series are included in our British Columbia material from the Kamloops and Nicola districts, Okanagan, North Thompson valley, Kootenays and Chilcotin (Mr. Buckell procured large series from the Barkerville district). Dyar and Shannon record it from Prince Rupert, Lake Atlin and Bear Lake. Small permanent streams with much aquatic vegetation, and even irrigation ditches are

often the source of great numbers of these flies. During June and early July this was the dominant species in a number of streams in the Kamloops district.

Species recorded from adjacent territory in western United States and Yukon which may occur in British Columbia

In addition to the species listed as definitely known from the province the following will probably be found as further collecting is undertaken:—**Prosimulium exigens** D. & S.; **Eusimulium canonicolum** D. & S.; **Eusimulium pugetense** D. & S.; **Simulium bivittatum** Malloch; **Simulium piperi** D. & S. and **Simulium venator** D. & S.

Description of a new pupa with unusual breathing organs and the corresponding larva

Of the eleven hitherto unknown pupae discovered during these investigations the one described below has perhaps the most unusual charactertistics; it has certain features that are rather unique as far as North American species are concerned and we have failed to find anything quite like it in the foreign literature at our disposal. Unfortunately it is not possible to state at the present time if it represents a new species or belongs to one of the blackflies already known in the adult stage, as for instance **Prosimulium fulvum.** Larvae were thickly encrusted on a cedar bough trailing in a fairly large swift-flowing mountain torrent in the Eagle valley near Revelstoke; few were found on rocks and boulders. The larvae were mainly fully developed and a number were placed on damp cotton wool where several of them pupated after two or three days. As is usual under these conditions, no pupal case was spun, but from the strong development of the two posterior hooks and arrangement and number of the various spines on the abdomen it seems probable that this is one of those species in which an irregular matting of threads takes the place of the ordinary well-constructed type of cocoon.

Pupa. Large, 5mm. long by 2 mm. wide; orange yellow in colour, only freshly pupated specimens available; mesonotum rather prominently humped, indications of three dark vittae; breathing organs in the form of two very stout tubes, ringed with a number of shallow constrictions and lying sub-parallel to each other, one tube shorter and smaller in diameter than the other; the common base from which they arise is very short and the division occurs fairly near the point of attachment on the thorax; from the apical quarter to apex of each large main tube arise a number of long thread-like filaments of rather uniform size; they are most numerous at the apex of the tubes and total thirty-seven in all, sixteen on the smaller tube and twenty-one on the larger; the apical segment of the abdomen is armed with a pair of unusually strong sharp hooks projecting in a dorsal direction; on each of the third and fourth segments dorsally are eight forwardly projecting, short curved hooks on the apical border; ventrally there are two forwardly directed hooks on each of the segments five, six and seven; from the third to terminal segments dorsally there is a band of closely placed minute spines at the base of the segments; these project posteriorly, and each band numbers several hundred.

Larva. When full grown 9 mm. long; yellowish; pupal respiratory histoblasts black and peculiar character of these organs plainly visible; triple anal gills simple without any small lateral "buds"; head capsule yellowish anteriorly but shading to brown posteriorly, markings brown as follow: central broad diffused stripe with pair of lateral spots each side of this; apical antennal segment thin, dark brown, basal segments broader and pale yellow.

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EPIDAPUS SCABIES. Hopk. AS A GREENHOUSE PEST IN VANCOUVER

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One morning during the first week in October, 1931, a commercial greenhouse grower from North Vancouver brought over for identification and suggestions of control, a quart milk bottle of rich greenhouse soil in which were enormous numbers of minute white worms. They resembled soil nematodes but were too big for these, being about 2 mm. long: microscopic examination showed them to be Dipterous larvae. They swarmed all through the soil but were distinctly gregarious, collecting together in white masses which showed as large as 50 cent pieces through the sides of the bottle. Slowly these masses moved from place to place while all larvae seemed restless, travelling incessantly.

Since the problem of control was immediate, the earth was transferred to a large stender, some being treated immediately with a cold saturated solution of sodium silico fluoride and some set aside for dessication at normal warm laboratory temperature. In two hours the larvae treated with fluoride solution were unharmed while those in the drying soil sample had left the surface of the soil and had collected on the bottom of the receptacle where the soil was still damp. Within six hours most of those in the drying soil were dead, so the owner was immediately advised by telephone to allow the affected soil to dry out as fast as possible, if necessary by turning on extra heat and by deeply raking over the soil at intervals to accelerate the drying out process without adopting any further treatment. He did this and rid his house of the pest within a few days. Up to the time of writing, March, 1932, he has had no further trouble with them.

History of the Outbreak

From this man and from other sources, I find that this type of infestation has appeared within the last six years, at least twice in North Vancouver and once in Vancouver itself. In all three cases the

outbreaks occurred in greenhouses. Growers maintain that the larvae appear in autumn and become a pest, completely destroying all crops planted in the soil, the crops being chiefly mushrooms.

Searching available records for identification, I find that these maggots are the larvae of a Fungus Gnat which, as nearly as I can determine, is probably **Epidapus scabies** Hopkins, or a closely allied species. The only description I can find is in Sanderson's manual of economic insects in which are reproduced Hopkins figures illustrating the life history of the pest. It was originally described by Hopkins in 1895 at West Virginia Agricultural Station; was mentioned again by Chittenden in 1907 and again by Gossard in 1911, and apparently not since then. It does not seem to have been recorded in Canada until now. In North Vancouver it appeared in 1928 and about the same time in the old Royal Nurseries in Vancouver; it was reported again in North Vancouver in 1931.

I bred out some individuals and the larvae, pupae and adults agree very closely with Hopkins' descriptions. The female is a wingless midge with a relatively very large abdomen while the male is winged and very much smaller. The female moves fairly deliberately over the surface of the soil while the male tears around at a great pace, seldom taking flight. Mating occurs very soon after the females emerge from pupal cases in the soil. Both sexes run to cover on the least atmospheric disturbance and are consequently best observed under a glass plate. At first sight, without magnification, they are not unlike certain Collembola.

Notwithstanding the greatest care I failed to rear any further generations and all died out. It may be that there is only one brood a year, in which case the minute larvae of the second generation are growing in the soil, which is being maintained in the laboratory for that purpose, suitably dampened and covered.

They are reported in literature as causing a scab-like blemish on potatoes, but injured and perfect, potatoes and carrots which I put into the stender, have so far not been attacked by the larvae.

As far as control is concerned, the drying out which I recommend almost at once, seems very effective against the myriads of larvae, provided that the process can be continued fast enough and deep enough to catch the downward-migrating larvae. One of the growers reported having used napthalene flakes over the surface of his soil, covered with canvas to keep in the fumes, and declared that he secured perfect control. Since this man uses napthalene as a panacea against a wide range of insect pests, I have either to change my views of napthalene or to proffer this as a second means of control in addition to the drying out process.

Acknowledgments.

I am deeply indebted to Dr. O. A. Johannsen for having confirmed my identification of these insects.

In a letter just received (31 May, 1932) he informs me that at Ithaca, N.Y., he finds them both in greenhouses and in fields, doing damage to potatoes.

BOOKLICE IN BRITISH COLUMBIA HOMES

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Within recent years three instances have come to my attention of outbreaks of Book-lice (Family Atropidae) in homes in British Columbia. Since two of these infestations had the same origin and since all three were of economic importance, it seems worth while to record them.

The first infestation occurred in 1926 when an outbreak of book-lice was reported in a house in Shaughnessy Heights, the fashionable residential section of Vancouver. The occupants of the home were distracted; one woman was hysterical. Inspection showed a very large house, scrupulously clean from cement basement floor to attic roof, with no visible material in which the book-lice could possibly breed. The house was inspected in minutest detail without accounting for the source of the insects, which could fairly readily be seen in all the rooms, on every article of furniture, in every clothes closet, between the sheets and on my lady's dresses on their hangers. They seemed to be thinly and evenly distributed about the house, and the only source discovered in any room was the baseboard behind which they ran for cover. Recommendations for control were puzzling since there was no definite source discernible. However, sodium fluoride was recommended to be applied as a fine dust around the periphery of every room. Enquiry two weeks later showed that the infestation was reduced to a point where the lice were inconspicuous.

The breeding ground of the Atropidae in this house was accidentally discovered shortly afterwards by carpenters engaged in replacing the draining board of the kitchen sink. Under the board and all around the sink were teeming hordes of book-lice which were immediately done to death in a variety of harsh ways. The infestation seemed to extend some distance up into the wall so the plaster was torn down from two sides of the kitchen and upon the entire area being renovated the whole infestation died out completely.

I am at a loss to account for the beginning of this swarm, or as to how they came to flourish under the draining board unless the insects were brought in originally in the fibre padding which is placed under the floor boards.

The second outbreak occurred in Victoria in 1928 in a newly built residence. Furniture purchased in February of that year revealed patches of mohair falling out during August, but no visible presence of marauders was apparent until a white linen cloth laid over the davenport became swarming with tiny insects. Specimens sent to the University were undoubtedly Atropids while those examined by an official of the museum in Victoria and also by an experienced upholsterer were reported as Buffalo "moths". It seems quite certain that these latter were causing the damage, while Atropids, already present, were breeding in vast numbers in the padding with which the furniture was upholstered. When food supply became scarce they began to spread through the house in a manner which caused much concern and anxiety to the inhabitants. The furniture was fumigated with carbon-bisulphide, but was so damaged that the dealers replaced it without further cost.

The third outbreak occurred in the autumn of 1931 in a recently built home in Point Grey (Vancouver). The identity of the insects had been grossly mistaken and their introduction had been attributed to a poor

youth to whom the lady had given a meal; for, shortly after this kind deed it was noted that numbers of tiny insects were swarming about, particularly in the proximity of the davenport and chairs. Personal inspection showed no sign of the insects on the floors since the room had been thoroughly scoured, and barriers of paradichlorbenzene laid down to prevent their spread. However, on the underside of the davenport and chairs and particularly beneath the tapestry were tremendous numbers of Atropids. Since a careful inspection of other parts of the residence revealed no traces of the pests it is concluded that the furniture (which must have been more or less stocked with them before leaving the storehouse) was the source of infestation and that they increased extensively until the food supply was depleted and then necessity forced them to migrate.

From these three instances noted we may conclude that while an infestation of book-lice may arise by breeding in damp and concealed parts of a building itself, it is more likely that they originate from furniture which has not been adequately sterilized before leaving the factory or warehouse.

Acknowledgment.

I am indebted to Professor G. J. Spencer for details of the first outbreak mentioned and for the opportunity to work on the third one.

A LIST OF THE ANTS OF BRITISH COLUMBIA

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In the Proceedings of the Entomological Society of British Columbia, No. 24, for 1927, the writer published an annotated list of twenty-nine ants which had been recorded from British Columbia prior to 1928.

Since that time and up to December 31st, 1931, collections from 150 nests in British Columbia have been determined and twenty-six new records established.

In the following list all the material was collected by the writer unless otherwise stated.

The writer is indebted to Mr. R. M. Smith, Prof. W. M. Wheeler and Dr. Mann for the identification of material.

Order **HYMENOPTERA**
Superfamily **FORMICOIDEA**
Family **FORMICIDAE**
Subfamily **MYRMECINAE**
Genus SOLENOPSIS Fabricius

(1) **Solenopsis molesta** Say:—Osoyoos, April 24th, 1925.

Genus PHEIDOLE Westwood

(2) **Pheidole oregonica** Emery:—Osoyoos, April 23rd, 1925.

Genus STENAMMA Westwood

(3) **Stenamma nearcticum** Mayr:—Recorded from British Columbia by Prof. W. M. Wheeler.

Genus APHAENOGASTER Mayr

(4) **Aphaenogaster subterranea** subsp. **occidentalis** Emery:—Okanagan Falls, April 24th, 1919; Naramata, May 2nd, 1919; Penticton, April 13th, 1919; Chilcotin, April 25th, 1920; Vernon, April 3rd, 1925; Kamloops, April 15th, 1925; Vaseaux Lake, March 17th, 1926.

Genus POGONOMYRMEX Mayr

(5) **Pogonomyrmex occidentalis** Cresson:—Keremeos, May 11th, 1919; Oliver, May 4th, 1924; Osoyoos, April 23rd, 1925.

Genus MYRMICA Latreille

(6) **Myrmica mutica** Emery:—Dog Lake, October 1st, 1913 (Dr. C. G. Hewitt); Okanagan Falls, April 24th, 1919; Summerland, April 20th, 1919.

(7) **Myrmica rubra** subsp. **brevinodis** var. **frigida** Forel:—Recorded from British Columbia by Prof. W. M. Wheeler.

(8) **Myrmica rubra** subsp. **brevinodis** var. **whymperi** Forel:—Recorded from British Columbia by Prof. W. M. Wheeler.

(9) **Myrmica rubra** subsp. **brevinodis** var. **sulcinodoides** Emery:—Minnie Lake, July 26th, 1925.

(10) **Myrmica rubra** subsp. **brevinodis** Emery var.:—Chilcotin, April 20th, 1920; Kamloops, April 16th, 1925; Barkerville, August 2nd, 1925.

(11) **Myrmica scabrinodis** subsp. **lobicornis** var. **lobifrons** Pergande (**glacialis** Forel):—Recorded from British Columbia by Prof. W. M. Wheeler.

(12) **Myrmica scabrinodis** Nyl, subsp. or var.:—Chilcotin, April 20th, 1920.

Genus LEPTOTHORAX Mayr

(13) **Leptothorax acervorum** subsp. **canadensis** Provancher:—Chilcotin, April 28th, 1920 (not typical).

Subfamily **DOLICHODERINAE**

Genus LIOMETOPUM Mayr

(14) **Liometopum apiculatum** subsp. **luctuosum** Wheeler:—Naramata, May 4th, 1927.

Genus TAPINOMA Förster

(15) **Tapinoma sessile** Say:—Fairview, May 19th, 1919; Penticton, April 23rd, 1920; Chilcotin, April 20th, 1920; Nicola, April 22nd, 1924; Kamloops, April 15th, 1925; Lillooet, May 27th, 1925; Osoyoos, May 24th, 1925.

Subfamily **CAMPONOTINAE**

Genus LASIUS Fabricius

Subgenus *Lasius* s. str.

(16) **Lasius niger** var. **neoniger** Emery:—Chilcotin, April 20th, 1920.

(17) **Lasius niger** subsp. **alienus** var. **americanus** Emery:—Okanagan Falls, April 24th, 1919; Nicola, April 22nd, 1924; Osoyoos, April 23rd, 1925.

(18) **Lasius niger** var. **sitkaensis** Pergande:—Salmon Arm, April 5th, 1925.

(19) **Lasius brevicornis** Emery:—Chilcotin, April 25th, 1920; Osoyoos, April 24th, 1925.

(20) **Lasius flavus** subsp. **nearcticus** Wheeler:—Naramata, May 22nd, 1919.

(21) **Lasius umbratus** subsp. **subumbratus** Viereck:—Keremeos, July 23rd, 1925.

Subgenus ACANTHOMYOPS Mayr

(22) **Lasius (Acanthomyops) interjectus** Mayr:—Kamloops, April 16th, 1925.

(23) **Lasius (Acanthomyops) claviger** Roger:—Penticton, May 2nd, 1919; Chilcotin, April 24th, 1920; Minnie Lake, July 26th, 1925.

(24) **Lasius (Acanthomyops) latipes** Walsh:—Kamloops, April 16th, 1925.

Genus FORMICA Linnaeus

(25) **Formica sanguinea** subsp. **subintegra** Emery:—Fairview, June 12th, 1919.

(26) **Formica sanguinea** subsp. **subnuda** Emery:—Salmon Arm, April 6th, 1925.

(27) **Formica sanguinea** subsp. **puberula** Emery:—Chilcotin, April 20th, 1920; Minnie Lake, July 25th, 1925.

(28) **Formica rufa** subsp. **obscuripes** Forel:—Kaleden, April 14th, 1919.

(29) **Formica rufa** subsp. **obscuripes** var. **melanotica** Emery:—Penticton, April 23rd, 1919; Chilcotin, April 20th, 1920; Minnie Lake, July 25th, 1925.

(30) **Formica rufa** subsp. **aggerans** Wheeler:—Chilcotin, April 25th, 1925.

(31) **Formica oreas** var. **comptula** Wheeler:—Fairview, May 5th, 1919; Chilcotin, April 20th, 1920.

(32) **Formica whymperi** Forel:—Emerald Lake (Collected by Prof. W. M. Wheeler).

(33) **Formica hewitti** Wheeler:—Emerald Lake (Collected by Dr. C. G. Hewitt)

(34) **Formica truncicola** subsp. **integra** Nyl:—Salmon Arm, April 7th, 1925.

(35) **Formica fusca** Linnaeus:—Barkerville, August 8th, 1925.

(36) **Formica fusca** var. **gelida** Wheeler:—Osoyoos, June 9th, 1919; Barkerville, August 2nd, 1925; Invermere, August 29th, 1925.

(37) **Formica fusca** var. **argentata** Wheeler:—Lillooet, May, 7th, 1925.

(38) **Formica fusca** var. **subaenescens** Emery:—Kaleden, April 14th, 1919; Chilcotin, April 25th, 1920; Osoyoos, April 23rd, 1925.

(39) **Formica fusca** var. **neoclara** Emery:—Chilliwack (Collected by Dr. C. G. Hewitt)

(40) **Formica fusca** var. **neorufibarbis** Emery:—Kelowna, and Kaslo (Collected by Dr. C. G. Hewitt); Chilcotin, April 24th, 1920.

(41) **Formica fusca** var. **narcida** Wheeler:—Chilcotin, April 20th, 1920.

(42) **Formica fusca** subsp. **pruinosa** Wheeler:—Fairview, May 12th, 1919.

(43) **Formica subpolita** Mayr:—Okanagan Falls, April 24th, 1919; Chilcotin, April 20th, 1920; Oliver, May 2nd, 1921; Kamloops, April 15th, 1925.

(44) **Formica subpolita** var. **camponoticeps** Wheeler:—Okanagan Falls, April 24th, 1919; Chilcotin, April 23rd, 1920; Kamloops, April 15th, 1925; Osoyoos, April 23rd, 1925; Lillooet, May 27th, 1925; Vaseaux Lake, March 17th, 1926.

(45) **Formica neogagates** Emery:—Fairview, May 21st, 1919; Chilcotin, April 20th, 1920; Osoyoos, April 23rd, 1925.

(46) **Formica neogagates** subsp. **lasiodes** var. **vetula** Wheeler:—Chilcotin, April 20th, 1920.

(47) **Formica cinerea** Mayr. var.:—Nicola, April 17th, 1925.

Genus POLYERGUS Latreille

(48) **Polyergus rufescens** subsp. **breviceps** Emery:—Chilcotin, April 20th, 1920.

Genus CAMPONOTUS Mayr

(49) **Camponotus levigatus** F. Smith:—Cranbrook, August 20th, 1925.

(50) **Camponotus maculatus** subsp. **vicinus** Mayr:—Osoyoos, April 23rd, 1919; Rockcreek, April 22nd, 1919; Lillooet, May 27th, 1925.

(51) **Camponotus maculatus** subsp. **vicinus** var. **nitidiventris** Emery:—Vernon, April 3rd, 1919; Chilcotin, April 25th, 1920; Kamloops, April 15th, 1925.

(52) **Camponotus maculatus** subsp. **vicinus** var. **luteangulus:**—Nicola, April 22nd, 1924.

(53) **Camponotus herculeanus** var. **whymperi** Forel:—Chilcotin, April 25th, 1920; Barkerville, August 2nd, 1925; Douglas Lake, June 1st, 1925; Revelstoke, July 2nd, 1925; Invermere, August 29th, 1925.

(54) **Camponotus herculeanus** var. **modoc** Wheeler:—Summerland, April 20th, 1919; Chilcotin, April 20th, 1920.

(55) **Camponotus herculeanus** subsp. **ligniperdus** var. **noveboracensis** Fitch:—Keremeos, May 11th, 1919; Fairview, May 3rd, 1919; Chilcotin, April 20th, 1920.

FURTHER NOTES ON RHYNCOCEPHALUS SACKENI, WILL.
(Diptera, Nemestrinidae)

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Last spring 1931, I presented before this Society certain records made in summer 1930, of flies laying eggs in telephone poles which were strung along the floor of a long shallow valley in the Chilcotin district of B.C. A closely related fly is reported in literature as parasitizing larvae of wood-boring beetles; I could not at the time reconstruct the life history of the flies I found. However, this past summer 1931, I had an opportunity of again inspecting these same telephone poles and present herewith the following further records which will partly clear up the problem of the habits of these rare flies.

The first visit was on June 3rd and I found three flies ovipositing on a pole, and just above ground level, a specimen of the Cerambycid beetle **Asemum atrum** Esch. alongside a new emergence hole in the wood. Last year I reported the poles as having no emergence holes of any insects in them; this season I noted my mistake, since the three

poles in question had many emergence holes of Cerambycid beetles from ground level to not more than 4 inches up, mostly concealed by straggling blades of grass around the bases of the poles.

The next visit was on June 9th when 18 ovipositing flies were collected and, alongside two new emergence holes, two specimens of the Cerambycid **Xylotrechus obliteratus** Lec. Moreover, two empty puparia, presumably of these flies, were partly protruding from a large crack in the wood. The puparia have been preserved but until I get definite confirmation, I cannot describe them as belonging to these flies.

A visit to another station three miles away on June 12th, took me to a lone poplar tree. This poplar was the sole survivor of one clump, of the prevailing clumps scattered all over the ranges, or occurring as fringing belts to the coniferous forests over most of the Chilcotin country. The previous season the tree had been a conspicuous green landmark on the open range; it was now dying and leafless. Buzzing round its 12-foot-high top like a swarm of bees, was a large number of flies. This was the first time I had found any in any place other than on the telephone poles; most were flying round the top of the tree, a few were laying eggs in cracks in the trunk. I collected 22 flies out of possibly three times that number flying around and on searching the ant-infested trunk, I found 2 **Xylotrechus** beetles about a foot above ground level. It was impossible to assign any particular hole as the exit hole of the beetles, because the trunk was riddled through and through by black ant tunnels.

The next day, June 13, the original station was inspected and 8 flies and 2 **Xylotrechus** removed from the three poles; an end pole had a new emergence hole but no beetle on it.

The same day, some dying poplars on a neighboring station some 200 yards away, were inspected and one **Xylotrechus** was found; there were no flies to be seen, on or near the trees.

At this time I was called to Lytton and did not return to the Chilcotin stations until July 3rd, when only one fly was to be found anywhere, and no beetles. To my surprise the emergence holes of the beetles in the posts had disappeared, and I found that during my absence the telephone repair gang had travelled the line and had pulled up these three posts, had cut off the portions sunk in the ground, and had replaced them with the areas containing the beetles holes, some three feet in ground. The telephone line had been installed in 1912 and in the following 19 years, for the repair gang to come and rebury my three poles only, out of the miles of poles on either side, seemed a cruel stroke of luck. However, I chopped up the rotten sawed-off basal parts and found 27 beetle larvae . . . mostly in one stump, the central one. These I packed in a quantity of the punk from which they came and took them to Lytton where, in a frenzy of grasshopper control measures, I forgot them for several days and on opening the container, found them all mouldy and flaccid. In my wish to rear them, I did not pickle or dissect any for fly larvae inside them.

These observations serve as additional short chapters to two previous papers presented before this Society, tieing the two subjects together . . . the one on "Beetles emerging from prepared timber after a period of years" and the other on the egg-laying habits of these Nemestrinid flies. To the first topic I now make this addition . . . here we have evidence of

beetles of two genera and two species **Asemum atrum** Esch. and **Xylotrechus obliteratus** Lec, emerging from dressed fir telephone poles at a distance of not more than 4 inches above ground level (with one exception of one pole only, of 14 inches), the poles in question having been installed 19 years previously. Either the larvae were already in the poles when these had been cut and had been undergoing development for at least 19 years, or else the parent beetles had laid eggs in them after they had been dressed, dried and posted. The latter suggestion is probably the correct one and is another link in my contention that some individuals at any rate, of the wood-boring families **Cerambycidae** and **Buprestidae** are capable of starting a new generation by ovipositing on dressed and drying timber and that the larvae on hatching from the eggs, are capable of establishing themselves on such wood without having to feed first on bark, cambium and sap wood, as has hitherto been considered necessary. It means also, that the eggs had been laid at, or near, ground level, and the grubs had worked downwards to feed and develop—and upwards again to pupate and emerge as beetles. How long this larval period lasted, it is impossible to say.

It is true that evidence is only circumstantial; I did not see the beetles emerging from these holes. The lone specimen of **Asemum atrum** may have been a transient; I do not think the others were. However, finding freshly-emerged beetles resting alongside of white, newly-cut, oval holes, is fairly strong circumstantial evidence.

Concerning the second phase of this evidence, we cannot fail to link together the finding of the beetles **Asemum atrum** Esch. and **Xylotrechus obliteratus** Lec. emerging from much-tunnelled and perforated poles—with the flies **Rhyncocephalus sackeni** Will. found in large numbers ovipositing in cracks in these poles, and in a dead **Populus tremuloides** from which I took two beetles. The inference is that the larvae of the flies are parasitic upon the larvae of the beetles named above or at least upon one of them, **Xylotrechus obliteratus** Lec.

Again, the evidence is only circumstantial. However, men have been hanged on much less evidence than this.

Acknowledgment.

Grateful thanks are extended to Mr. Ralph Hopping for identification of the beetles mentioned.

REFERENCE:—

Williston, Manual of North American Diptera.

THE LIFE HISTORY AND BEHAVIOR OF THE EUROPEAN EARWIG, FORFICULA AURICULARIA, L. IN BRITISH COLUMBIA

GEOFFREY BEALL

Introduction

The European earwig, **Forficula auricularia,** L., has been studied by previous investigators in British Columbia, but some features of its life history have not been made known. This paper fills many of the gaps, largely by the use of quantitative methods*.

Historical Background

The European earwig, **Forficula auricularia,** L., has become an extremely objectional garden and household pest in Vancouver and nearby British Columbian cities. In order to check it, extensive control work has been carried out by the authorities. Upon this problem some local investigation was made in 1926 and 1927 by J. Stanley of the University of British Columbia. He studied life history, seasonal development, and control measures. However, the main basis of the control work has been the findings of B. B. Fulton of Portland, Oregon.

Outline of Investigations

In 1929, May to September inclusive, a further study of the earwig was undertaken in New Westminster, twelve miles from Vancouver. The research included studies on parasitism and mechanical control in addition to work done directly on the life history. The two former, although not included in this paper, contributed much incidental data. Further field notes were made and rearing was carried on during the winter 1930-31 to complement the material previously gathered in the summer.

FIELD OBSERVATION ON EARWIG HABITS

Trapping and rearing of the earwig, together with continuous observation of the life history, were carried on over a period of two years.

Winter Observations

Place of Hibernation

According to Fulton ('24) the earwig overwinters "under boards or stones on the ground or in cavities in the ground, an inch or two under the surface, rarely deeper." Although this statement is true for British Columbia, it was extremely difficult to find earwigs even in these situation in the winter. City blocks harboring earwigs by the tens of thousands in the summer have failed to yield one earwig in hours of searching, during the winter. Other entomologists in British Columbia have had the same experience. Earth to a depth of two feet, matted old leaves, bases

*Mr. A. Gibson, Dominion Entomologist, has been kind enough to allow me to use government data in this paper. To Mr. R. Glendenning I am deeply obliged for his direction and assistance in the summer of 1929. To Dr. C. M. Fraser, Department of Zoology, I am indebted for permission to publish these results. The actual preparation of field data, as well as further experiments, were carried on under Professor G. J. Spencer to whom I am greatly obliged. I am also grateful to Mr. D. A. Arnott, Chatham, Ontario, to Dr. W. V. Balduf, University of Illinois, to Prof. C. F. Drummond, University of British Columbia, and to Mr. G. M. Stirrett, Chatham, Ontario, for assistance in various ways in carrying out this work.

of trees, hollows in trees, upper parts of thick bushes, half buried planks, dry sheltered earth under verandas, and dry and wet piles of firewood, have been searched in vain. Occasional earwigs have been found in the decayed external layers of the bases of electric power poles exposed in the course of road work: also in one case an earwig was found in a buried piece of rubber tubing.

The only type of situation yielding earwigs in numbers has been steep banks. They occurred in considerable numbers under the small stones in a rockery forming a wall about four feet high bedded in stony soil. Similarly, earwigs were found at the top of a gravel cutting along a road. Both rockery and bank had a southern exposure. It was impossible to say what conditions governed the choice of these spots, since similar banks and parts of the same banks were unoccupied. It appeared in the latter case that the Isopods were much more numerous in those parts of the bank where no earwigs occurred. Possibly the determining factor was soil drainage. The earwigs were found in cavities in the earth against the stones.

Breeding in Winter

In the banks which did harbour earwigs, eggs were found quite early in the winter. The season of 1931 was unusually mild with very little frost, so that this reproductive activity may have been abnormal. At any rate, three out of nine females found in January 14 were tending eggs. Part of one of these clutches removed to the zoological laboratory hatched in nine days. Comparison of this period with the thirty-one days incubation required by eggs laid in the laboratory suggests that the field eggs had been laid for some time before being found. Females were found in various January collections to have laid eggs. Three females taken on February 14 were brooding eggs.

The possibility that the female earwigs were occupied with, or preparing for, oviposition during January and February, 1931, is substantiated by the fact that, while the males were wandering freely, the females were not. This idea was suggested when stones of the rockery which had been lifted January 17 were again searched February 3. Under the stones that had been previously raised to remove the earwigs, about forty-five males, but no females, were collected. This situation recurred on February 27, when thirty-six males and only one female were found under the same stones. Apparently the only females captured during this period were from situations previously undisturbed. It was further noticed on February 3, after several warm days, that a large number of earwigs, exclusively male, had moved out from the embankment under some creepers at the foot.

Spring and Summer Observation

A variety of observations, including oviposition, nesting, copulation and copulation behavior, were made during the spring and summer.

Second or Delayed Oviposition

In May and June, some overwintered adult females were wandering freely at a time when the majority of them was caring for brood. They occurred in the trees even more than on the ground, as was definitely proven in quantitative trapping, which would seem to indicate that they were in no way associated with nests. Dissection of thirty such earwigs during the last fortnight of May showed almost all to carry eggs at all

stages of development. This phenomenon suggests that a second or delayed brood occurs in the field. The fact that females can produce a second clutch of eggs was conclusively demonstrated.

From among the numerous females dug up on May 16, 1929, thirty-three, or about one-third of them, that were quite definitely tending brood, were selected. These were put in an enclosure that did not permit ingress or egress. No males were added. As described below, fungous disease was very serious among these overwintered adults so that most died. However, by June 7, six surviving females were found to have nests on the surface of the ground under pieces of wood. Of these, five had 41, 44, 45, 33 and 57 eggs, respectively, while one lot was not counted. Of these six females, two survived to hatch their eggs. This process was completed on June 26. On July 2, a third nest was found under the ground with the eggs not quite all hatched. These three surviving females and an overwintered male were put in a suitable jar to see whether they would produce a third brood. None was obtained, although all these females survived for a number of weeks, and one lived until the first week in October.

Earwigs Nesting Above Ground

In two cages used primarily for the study of parisitism, some earwigs were noticed to nest above ground, in contrast to their usual subterranean habit.* In these cages, which were six feet square, two lots of about 100 adult overwintered earwigs were confined. About sixty per cent. of the many clutches found were in the folds of newspapers, which were scattered about. This paper teemed with other adult earwigs, a condition which would not seem to favor egg laying. The remainder of the nests were on the surface of the ground, mainly below the paper. The soil could not be turned over to determine how many nests were below ground.

It is possible that this nesting above ground was due to the wet condition of the soil. In the case of ten females kept individually in glass quart jars, none laid in the available folds of paper and only one on the surface of the soil, while the rest oviposited below the surface. This soil was much drier than that in the large cages, although it was also less crowded.

A field occurrence of this modified nesting habit might be sought in city blocks having very wet soil even in the hot summer. Such a district lies about Trout Lake at the bottom of a drainage basin in Vancouver south. It is difficult to suppose that earwigs breed in the normal way, underground, in such a place. This region was found, in an inspection made in August, 1929, to be lightly infested with earwigs.

Period of Copulation

In the spring of 1929 a great many males were found to have overwintered. They were a sluggish group which died off rapidly, even compared with the companion females. Nevertheless, these males retained the capacity to fertilize the females until their end. In the stocks of earwigs maintained in the large cages, at least four definite cases of copulation were seen during the first fortnight in June. In stocks of earwigs maintained during the winter of 1931, copulation was found to occur at all times.

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*See description of cages, p. 32.

Fungous Disease

In the large cages for study of parasitism the 2000 adult overwintered earwigs introduced in the spring practically all died before the new generation of individuals became adult. The most common cause of death appeared to be a fungous disease. This apparently did not attack nymphs to the same extent as the adults. It occurred mainly between the sclerites and between the abdominal segments, and in the nymphs where the body wall was thin. The probability that the fungus is more than saprophytic is suggested by the fact that earwigs are commonly seen moving about feebly with the first hyphae appearing. Death occurs about twelve hours later. The body after death is bloated and filled with mycelia. An identification of this fungus was not obtained, since no fruiting bodies could be found internally. Fruiting bodies of **Mucor,** which was probably secondary, were found plentifully on the surface.

So far as could be seen, this fungous disease occurred among earwigs when high relative humidity coincided with warmth. In the summer of 1929 it was found especially in the large parasitism cages where the soil became very wet in spite of all efforts to protect it from rain. Also, the disease was very much more severe during the winter among adults kept in the zoological greenhouse or in the laboratory than among the earwigs seen in the field. It was suggested that the susceptibility of the insects to disease under the preceding conditions was occasioned by a combination of wet conditions and relatively high temperature. This hypothesis was suggested by the fact that when the diseased lots of earwigs were put in an open window, where the winter draught could blow over the containers, the death rate declined greatly. This situation was never cold enough in 1931 to freeze the moisture in the tins. At the same time, some tins of earwigs, which had been kept on the ground beneath a house, had remained practically free from disease while there. Although the temperatures were moderately low in this situation, the earwigs were quite active, even engaging in oviposition. Upon removal of the tins to a room which went up to 70° F. for many hours a day, the fungous disease literally flared up.

Autumn Observations

During the autumn, not many observations were made on the life history of the earwig other than some which are discussed under the topic "Trend of Population."

Food Habits

The earwig is omnivorous, as many writers have reported. The common crucifer, **Sisymbrium officinale,** L., white clover, **Trifolium repens,** L., and dahlia, **Dahlia variabilis,** were found to be favorites, apparently in the order given. The adults in cages were found to eat the leaves of many plants, including those of dandelion, **Taraxacum officinale,** Weber, large leaved maple. **Acer macrophyllum,** Pursh, and hollyhock, **Althaea rosea,** Cav., if other food was not available. Much pollen was found, by dissections, to have been eaten. That of fruit trees early in the season, and of dahlias later, were eaten. The earwigs ate pulverized apple and also drained the druples of raspberries, when in captivity. Under this condition they were also found to eat boiled beef and liver, and fresh bread crumbs, upon which diet alone the earwigs thrived. As far as could be seen, there was no difference between the kinds of food eaten by nymphs and by adults, respectively.

Adult earwigs were collected at 3.30 a.m., May 20 and 23 in order to determine what they had eaten during the night. Eleven of these examined in detail contained **Pleurococcus,** in most cases in large quantities, as well as other food. Since this alga seems to occur in a simple lichen, the accompanying hyphae were sought. Apparently branched and unbranched filaments were present, although this observation was not confirmed by a botanist. Lichen containing **Pleurococcus** occurs almost universally on trees, poles, fences, etc., about New Westminster. The nature and importance of the arboreal habit of the earwig may perhaps be determined, after more extensive examinations of this sort, to be connected with the occurrence of lichen on the trees.

Two cases of cannibalism were seen in the field, while in the cages, earwigs killed with scalding water were eaten readily by the living. In the rearing experiments of the winter, the female earwigs ate a great many of their own eggs. This occurred in spite of the fact that plenty of food was present. In one particular case, a quiescent female, when disturbed, picked up an egg, drained it and then swallowed the skin.

Relationship Between Distribution of Earwigs and Density of Human Population

In the former municipality of South Vancouver, the degree of infestation by earwigs apparently varied directly with the degree of human occupation. The northwestern part of the district adjacent to the City of Vancouver, and a strip along the Kingsway highway are largely occupied by dwelling houses; the southern part, particularly in the east, is largely unoccupied. In the northwestern part the majority, and in the southern regions the minority, of the lots per block are heavily infested. While a relationship like that suggested here, has been generally assumed to exist, this data would make its quantitative demonstration and evaluation possible. Unfortunately, time has not been available to make this study possible.

REARING EXPERIMENTS

Rearing was carried on under modified outdoor conditions in 1929 and under laboratory conditions in the winter of 1930-31. This work was fairly successful. In the first case, about 50% of the young nymphs introduced into the cages, and in the second case 92% of the earwigs hatched, reached maturity.

Conditions and Procedure in Outdoor Rearing

In the course of an attempt to obtain parasitism of the earwig, in the summer of 1929, two large cages were set up. The first two thousand nymphs captured in 1929 were put in the two cages. In addition, a few nymphs were bred from adults which were placed in the cage at the beginning of the season. Although this experiment was not undertaken with the object of gaining data on the life history, some were obtained incidentally.

The earwigs were kept in an enclosure formed by setting twelve inch by one inch planks four inches into the soil with barriers on the upper edge to prevent the escape of earwigs. Each cage was six feet square. Walls and a roof of cheese-cloth were added for the purposes of the study of parasitism. Within these cages the air movement was naturally less than outside, and the temperature and relative humidity were higher. In order to keep the ground as dry as possible, the cages were covered with oil-cloth at night and during rains.

Conditions and Procedure in Laboratory Rearing

During the winter of 1930-31, eighty-nine earwigs were reared to maturity in the zoological laboratory. The eggs used were obtained from earwigs captured in September, 1930, in New Westminster. The males and females had been kept together during the autumn in cages and tins in the university greenhouse and in the zoological laboratory. The female, with her eggs, was isolated as soon as she began to lay. As soon as hatching was completed, the mothers were removed. The nymphs were kept under constant observation until they became adult.

Both the nests of eggs and the nymphs were kept in seamless tins, which were two and three-quarters inches in diameter and three-quarters of an inch deep, and provided with tight fitting lids. Since the earwigs were kept on damp towel paper, the air in the tins was always saturated with water vapour. A thermograph was kept beside the tins of developing earwigs. It is sufficient to say that the average room temperature was 62° F., with a general fluctuation of 3° F., and a maximum of 11° F.

The young during this winter were fed upon freshly mashed boiled beef liver, freshly crushed bread, and freshly mashed apple. At the time of hatching, sprouting wheat was added, and afterwards the leaves of dahlias. This additional part of the diet was probably unnecessary.

In order to reduce disease among the nymphs, the containers, food and paper were at first changed every day, then every two days, and finally every three days. Care was taken always to use cleaned tools for the different sets of earwigs.

Conclusions on Rearing

1. Length of Instars

The average duration of the various stages under the constant and presumably favorable conditions of the laboratory were:

Stage	Egg	Instar I	Instar II	Instar III	Instar IV
Days duration	31	14	14	13	19

The method employed in calculating the average duration of the stadia is to find the periods between the median days of the various periods of metamorphosis. Thus, the day on which 50% of the moults from first instar to second instar had been completed marks the lower limit of the duration of the second instar, and the date on which 50% of the moults from the second to the third instar had been cast determines the other limit of the second instar. The average period thus determined is fourteen days. Similarly, by a determination of the median day for succeeding periods of ecdysis the average duration of the succeeding stadia are determined. By an obvious extension of this principle, the average duration of the egg state and first instar are calculated.

In Figure I the actual numbers of moults per day is shown together with the median days of laying and hatching. However, the representation of the appearance of adults is modified to show the appearance of males and females separately. The earwigs are subdivided into three lots. Lots I and II each consist of the young from one clutch. Lot III consists of the young from two clutches laid concurrently. As can be seen from this chart, there was remarkably little variation in average

length of the stages from the three lots. This agreement makes the calculation of average duration of instars shown above very reliable.

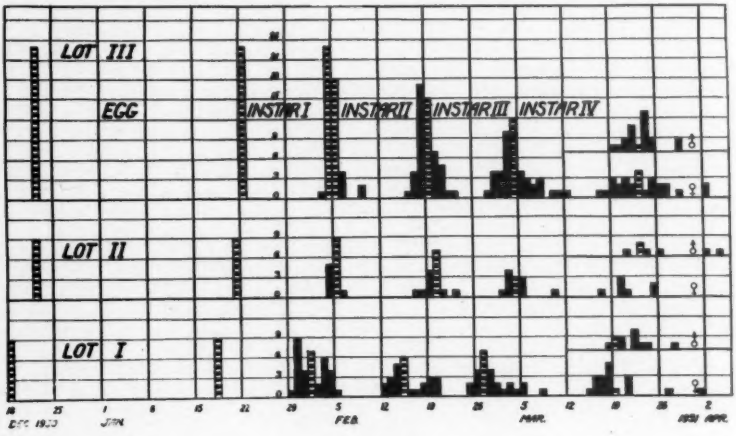

FIGURE I

Data on Rearing Earwigs

The number of moults cast daily is shown by solid black columns and the median day of each period of ecdysis is shown by striated column. The number of moults cast each day in the various groups is indicated by the height of the columns. One division represents three moults.

2. Statistical Scatter in the Period of Metamorphosis

The scatter of the period of metamorphosis increased greatly as the earwigs developed, even under the constant conditions to which they were subjected in the laboratory. The standard deviation of the length of periods of ecdysis from lot III measures this tendency as shown:

Moult	I	II	III	IV
—in days	$1.11 \pm .07$	$1.35 \pm .09$	$2.58 \pm .18$	$3.48 \pm .24$

This increase in scatter, indicated by these figures, can be seen in Figure I.

3. Chronological Appearance of Adults by Sexes

The females became adult a day or so earlier than the males.

4. Proportion of Sexes

Among the eighty-nine earwigs reared in the laboratory, fifty-two were female and thirty-seven were male. Thus $41.6\% \pm 3.6\%$ of the population was male. The formula used is $PE = .6745 \sqrt{\frac{p \cdot q}{N}}$ when in this case p=number of males; q=number of females; and N=p+q. By the same formula, the probable error of an expected 1/1 ratio between the

two sexes in a total population of eighty-nine would be 3.2 earwigs. Therefore, the deviation of the experimentally obtained ratio of 7.5 earwigs from a 1/1 ratio has a probable error of ±4.6 earwigs. That is, there is one chance in four that the experimental ratio deviated as it did from a 1/1 ratio, by chance. However, outdoor rearing gives additional support to the supposition that males form less than half the adult population. Of 1181 adults reared from nymphs captured in June, 1929, 45.5% ± 1.5% were male. The difference between this latter ratio and that from indoor rearing is 3.9% ± 4.2%.

5. Dimorphism in Males

Male earwigs exist in two non-intergrading groups—those with short and those with long cerci. It had been originally expected to observe the proportions in which the two forms appeared and to see whether they matured simultaneously. However, all the thirty-seven males obtained had short cerci.

QUANTITATIVE STUDY OF EARWIG POPULATION IN THE FIELD —THE TREND OF POPULATION

The life history of the earwig throughout one summer is described below from a quantitative view-point. The main gauge used is the number of earwigs caught in a large number of widely separated traps. Results of other experiments, particularly rearing, are used to support the trapping observations. Apart from the biological interest of the material, it is of the highest value economically as a basis of control work.

Procedure in Trapping Earwigs

Extensive trapping was carried on in the months May to September, inclusive, 1929. One hundred and ten traps of various sorts were set out on eleven lots lining the periphery of a square mile of the hill on which New Westminster is built. The traps were scattered so that the results obtained might be as general as possible.

Of the eleven city lots used for trapping, eight were well-kept gardens, one was a deserted garden, one a small orchard, and two were unimproved lots covered with bush and grass. On eight lots, referred to as "trapped lots", the earwigs were destroyed as captured, and on three lots, referred to as "control lots", the insects were returned to the ground near the trap after the count had been made.

Traps Used

The traps used in the collection were very simple. They fell into three groups, according to their position; those in trees, those on stakes, and those on the ground.

The tree traps, which were five feet above the ground, consisted of:

1. Jute sacking bundled up in the crotches of trees;
2. Jute sacking around the trunks of trees;
3. Newspaper bundled up in the crotches of trees.

The traps which were eight inches above ground on stakes consisted of:

4. Inverted flower pots filled with grass;
5. Inverted tin cans filled with newspaper.

The traps on the ground consisted of:

6. Old dry dahlia stems;
7. Sections of bamboo, node and internode.

Collection Period

During the first three months of trapping, May, June and July, collections were made nearly every day from some of the traps in each group. A total of about 1200 visits a month were made to the one hundred and ten traps, and an average of 13,000 earwigs taken per month. Only a selected group of traps, those in which the greatest numbers of earwigs were caught, could be maintained over August and September. During this period, three hundred and forty visits a month were made to thirty-four traps and an average of 2500 earwigs taken per month. Some further trapping was done by a helper in the late autumn of 1929 and early spring of 1930. A little parallel trapping was carried on in Vancouver, twelve miles away, concurrently with that of New Westminster. The earwigs were seen to be behaving similarly in the two places.

Arithmetical Deviation of Life History Chart

Figures II and III show the trend of population. The average catch for one trap for one collection is depicted for each day on which collections were made. The catch from the "trapped lots" is more extensive than that for the "control lots", so is used in the life history charts which follow. In describing the derivation of the charts, that for the tree traps is first considered.

The total catch of nymphs and adults per average trap per day is calculated for the whole season from the select group of tree traps visited continuously throughout the five months. This was the five tree traps that caught the most earwigs in the first three months of trapping. The median yield for the first month per collection for the group was twenty-two earwigs, and for the remaining four months sixty-nine earwigs. A five day moving median is used to give the averaged, daily, total catch throughout the season. The median is used, since it is influenced less by extreme, abnormal catches than other possible measures of central tendency. Moreover, it shows the turning points and termination points of a curve or histogram clearly and accurately.

The percentage composition of the daily catch in adult males, adult females, and various nymphal stages, is determined independently of the averaged total catch per trap, previously determined. It is based upon the catches from all tree traps visited on each day. In the course of the season, thirty tree traps were operated, some for short and some for long periods. Thus the composition of the catch might be based upon all thirty traps on one day and on twenty-one traps the next day. In all events a great many earwigs were collected. These daily collections are smoothed with a three day moving-arithmetic mean, largely to reduce fluctuations in catch which were caused by weather disturbances. Projection of these percentages into the averaged total daily catch per trap, as already determined, gives Figure II.

The percentages for the whole period are based upon about 20,000 earwigs. In the course of the five months 12,786 dead nymphs from the ground, stake and tree traps, collected over forty-six different days, were identified as to instar by a binocular examination. For the first part of the season, the earwigs examined included the total catch of nymphs; later only a sample was taken as a check on the field determination. The field determination has been used, for the most part, as the data for the calculations.

For determining the general level of population, which changes fairly slowly, the five day smoothing period is desirable. It includes enough individuals to be reliable and extends far enough to smooth out short period variations in catch occasioned by weather. Moreover, the figures throughout the entire five months should be comparable, since they are based upon exactly the same traps.

In determining the relative abundance of the various groups of nymphs and adults, particularly of the former, since the numbers present change quite rapidly, the short period, three day, smoothing is desirable. The number of traps used or their relative effectiveness individually should not affect the ratios of the various groups in the total catch, since the various groups should occur equally in all like traps. However, since any one group forms but a fraction of the total catch, the percentages have been based upon a maximum number of traps, that is, a maximum catch. In this way the degree of reliability of the percentages obtained has been raised.

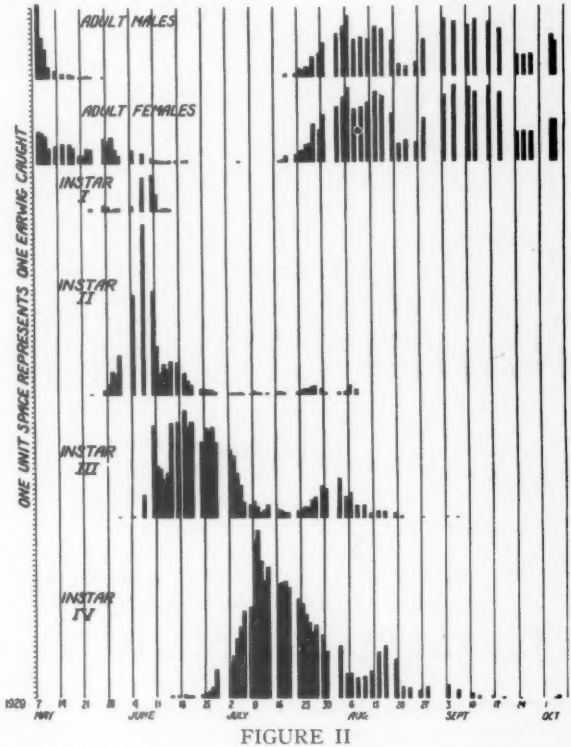

FIGURE II

Averaged daily catch of earwigs per trap for tree traps, five feet above ground. The total catch is resolved into component parts on nymphs according to instar and adults according to sex.

NOTE:—The actual number of earwigs caught is of little significance, since it depends upon the choice of traps. The fluctuations of the component groups are significant.

For the traps on stakes the procedure in plotting catches over the five months is identical with that described above for tree traps. Seven traps were maintained continuously over the period. The median yield per trap per collection during the first month was eight earwigs, and during the remaining four months, twenty-four earwigs. Eighty different traps were operated at different times during the season. The percentages of component groups are based upon 20,000 earwigs.

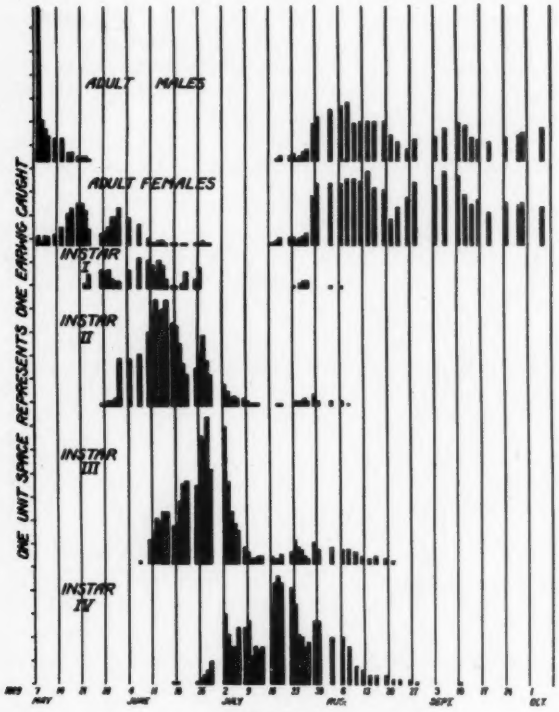

FIGURE III

Averaged daily catch of earwigs per trap from traps on stakes, eight inches above ground. The total catch is resolved into component parts of nymphs according to instar, and adults according to sex.

NOTE:—The actual number of earwigs caught is of little significance, since it depends upon the choice of the traps. The fluctuations of the component groups are significant.

Conclusions with Regard to Seasonal Behavior Made on the Basis Quantitative Studies

1. Survival of Males in Spring

In 1929 adult males were a significant fraction in the population until the third week in May, and a non-significant fraction all summer. In Rhode Island almost all male earwigs and apparently the majority of females (Jones '17) die during the winter. The differences in survival of adults in these two places for these two years suggests the lower

winter temperatures of the eastern coast may be important in controlling the earwig. In the west, as pointed out in the preceding discussion of disease, it is possible that the wet, warm conditions of the spring are responsible for most of the deaths occurring among the overwintered adults.

2. Females Without Brood in Spring

At the beginning of May, a portion of the adult female earwig population, in contrast with the majority, were by no means restricted to the ground with their brood. On the contrary, they occurred more freely in the tree traps than in the ground traps. This activity demonstrates clearly that these females were not in any way occupied with caring for brood.

The female catch became very much reduced in the fourth week of trapping. This was not primarily a result of trapping, since other groups, particularly the autumnal adults, showed no marked tendency to disappear from trapped lots. The decline in numbers of these vernal adult females may have been due to the fact that they had died, or to the fact that they were tending delayed brood or second brood; and therefore, not entering the traps.

3. Proportion of Males in Population

Among the adult earwigs obtained by trapping in British Columbia, the proportion in which males occurred agrees with that found in a similar way by H. H. Brindley ('12) in England. Collections made from the middle of July until the beginning of October, 1929 are compared with English collections made during August and September (with a little work in October) during the years 1892-1911. For New Westminster, the catch from traps on stakes was 37.9% male, from tree traps 42.1% male. In twenty-four English situations males formed less than half the population and in five, more than half. The median proportion was 38.9% male.

The proportions of sexes obtaining among earwigs reared from eggs to the imaginal stage is very close to the proportions caught in the field, i.e. 45.3% $\pm$ 1.5% and 41.6% $\pm$ 3.6% male, respectively. Of course, field catches are a reflection not only of these relative proportions of the two sexes, but also of differences in their activity.

4. Chronological Appearance of Adults by Sexes

In the field, as in the winter rearing experiments, the female earwigs were observed to reach maturity two days, on the average before the males. This is apparent from Figures II and III.

5. Second Brood or Delayed Brood

During the years the earwigs were studied, young seemed to occur at practically all seasons. As previously stated, eggs were found outdoors on January 14, 1931. On the other hand, nymphs were taken in traps on November 10, 1929.

Not only were nymphs present at other times than on the occasion of their main appearance in June, but they also showed a second similar period of abundance early in August. Nymphs of the first instar, which had not occurred in significant numbers since June 25 in ground traps, were again found there after July 23. This is shown in Figure III. The catch of second, third and fourth instar nymphs in tree traps rose successively after periods of steady decline on July 23, July 23, and August 13, respectively. This is shown in Figure II.

By way of analyzing the nature of the distribution of numbers of nymphs, the modes of the first and second periods of abundance from trees and ground (Figures II and III) were chosen by sight. These data have been replotted in Figure IV.

a. The distribution of the modes for the various instars against time is of similar arrangement for first and second periods. However, the intervening time in the second period is uniformly shorter. This would be expected later in the season when development would presumably be more rapid.

b. The interval between the modes for the second and third instars is shorter than that between the modes for the third and fourth instars. This evidence, that the third instar is of shorter duration than the fourth, agrees with evidence obtained in breeding, when the periods were thirteen and nineteen days, respectively.

c. An apparent discrepancy exists in that the modes for the first and second instars fall on the same day for the first period of abundance and within half a day for the second period. Also, as is shown in a subsequent discussion, a further discrepancy arises in that, although nymphs of the second instar climbed fairly freely and were, therefore, presumably moderately active, very few of them were taken in traps. For the other instars, the numbers taken in traps and the relative activity are closely correlated. In view of these irregularities, it is suggested that the first instar behaves far less uniformly than subsequent stages, and that the data obtained really deal only with nymphs of the last few days before their first ecdysis.

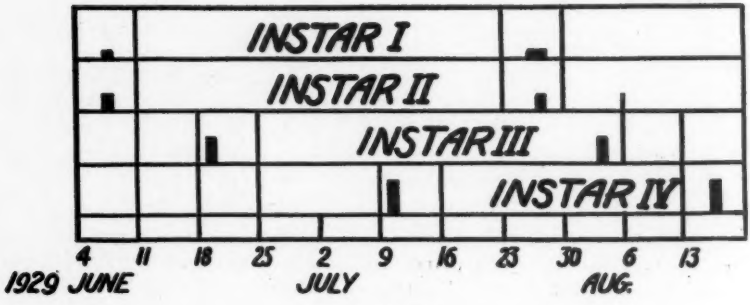

FIGURE IV

Modes of First and Second Broods for Each Instar

The modes for the first instar are taken from traps on stakes and for the remaining instars from tree traps.

Evidence previously presented in this paper for the existence of a second or delayed brood is summarized below. In the first place, a large group of females was not at all engaged in reproduction in May, when the majority of the females had brood. Possibly this group oviposited later, since the majority contained well developed eggs in May. In the second place, it was demonstrated that females deprived of their eggs on May 16 produced second clutches by June 7.

6. Comparison of Activity of Different Groups

A measure of the relative activity of nymphs of different instars may be obtained from a comparison of the respective numbers caught in tree traps. In the following table the numbers which were caught in each instar are compared with the number in the first instar:

Instar I	Instar II	Instar III	Instar IV
1.0	6.9	11.5	16.1

However, as can be readily seen, there are two ways in which these indices are subject to error. In the first place, deaths must occur in each instar, so that of the original population hatched a smaller percentage must survive into each subsequent instar. This phenomenon would tend to reduce the index for the older stadia. In the second place, while the first three instars take about the same time to develop, the fourth instar has a period 19/14 times as long, as was shown previously in discussion of rearing experiments and of trapping. Therefore, it would occur more frequently in traps than the earlier instars.

The preceding difficulties may be overcome by comparing the number of earwigs of any one group caught in the tree traps and traps on stakes, respectively. Moreover, this procedure makes it possible to compare the activity of the adults for the whole period or for any portion of their period, with the nymphs. A comparison is made below of the number of times more numerous the catch was for average tree traps than for average ground traps:

Vernal adult females	Vernal adult males	First instar nymphs	Second instar nymphs	Third instar nymphs	Fourth instar nymphs	Autumnal adult females	Autumnal adult males
3.2	2.1	1.9	3.9	5.1	5.8	4.6	5.5

It should be pointed out that the value of these indices lies largely in comparison with one another. The figures for the first instar are not typical because, as was shown in connection with Figure IV, probably only a small group of the oldest nymphs are represented.

The conclusions of the two preceding tables may be summarized as follows: The nymphs of the second instar are half as prone to climb as the third and fourth instars. The overwintered males are very inactive even in contrast with the companion females.

7. Heights Above Ground at Which Nymphs Occur Throughout the Season

In concluding the discussion on the behavior of the earwig, a general statement may be made on the extent to which earwig nymphs, considering all instars as a single group, climb. Figure V pictures the catch of immature earwigs from traps on the ground; traps on stakes, eight inches above the ground; and traps in trees, five feet above the ground.

The data for the five foot traps, or tree traps, is the same as that used for Figure II. The catch in each of the four nymphal instars is totaled and the results plotted as a curve. This curve is smoothed with an eleven day moving median. The data used in constructing Figure III

is treated in a similar way to draw up the curve for the eight inch traps, or traps on stakes. In addition to this data, which has previously been presented in a different form, further material not appearing before is used to give the average catch for the traps on the level of the ground, "O inches". The traps used were old, dry dahlia stems and sections of bamboo. Since it is practically impossible to compare the catch from one type of trap with that from another, the total area included in each of the curves is made the same. The slopes, but not the heights, of the curves are significant and comparable.

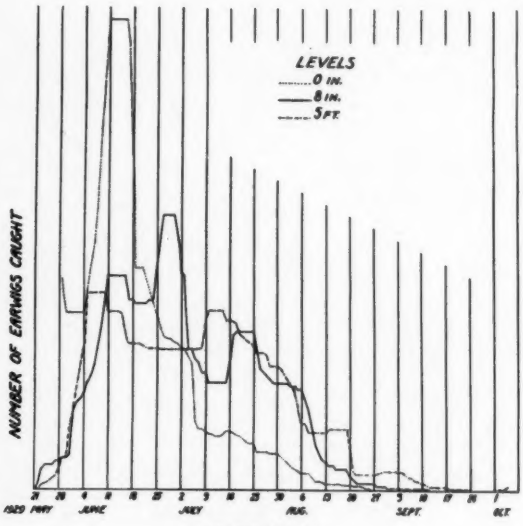

FIGURE V

Total Catch of Nymphs from Traps at Three Levels

From Figure V it can be seen that after about June 14, when the first instar predominated, the earwigs climbed with increasing freedom. The later instars did not go into the traps on the ground to any extent. On the other hand, they did not show any marked preference beween the eight inch level and the five foot level, at any rate, not before August 10. The number of earwigs occurring at the eight inch level and five foot level apparently varied inversely with regard to minor fluctuations in population.

SUMMARY OF CONCLUSIONS

Nymphs were continuously present in the field from the beginning of May until the end of November in 1929. Two periods of abundance occurred with their maxima in the middle of June and the end of July. In the field the fourth instar required 1.8 times as long as the third to complete its development. In the second period of abundance the stadia were only .6 as long as in the first. In rearing under constant conditions, the nymphal stadia were 14, 14, 13 and 19 days respectively. In both rearing and field work females became adult a day or so earlier than the males. The latter only formed 40 per cent. of the population in the autumn.

On January 14, 1931, females were found with eggs, one clutch of which appeared to be at least half way hatched when removed to the laboratory. Females removed from their eggs in May laid second lots of from 41-57 eggs. Other females, that were climbing freely when the majority were tending brood, contained well developed eggs. Taken all together the evidence suggests that a considerable number of eggs was laid, after the main period of reproduction in the early spring.

Earwigs were only found during the winter on stony banks. Males die off earlier in the spring than females, although they apparently overwinter to about the same extent. From concurrent behavior in outdoor cages and a few observations of dead earwigs, fungous disease was responsible for their deaths. In winter work this disease occurred among adults brought from temperatures near 40° F. to about 65° F., or slightly higher.

Quantitative expressions of the relative activity of different groups of earwigs were obtained by a comparison of numbers of each group occurring in accessible traps with numbers in less accessible traps. Nymphs of the first instar appeared only at the end of their stadium above the ground. The second instar and vernal adults climbed freely. The third and fourth instars climbed about twice as readily. In the spring females were more active than males, while in the autumn males were the more active.

The correlation between density of human population and earwig infestation was demonstrated in a detailed survey of South Vancouver.

A limited number of earwigs which were dissected were found to have eaten **Pleurococcus.**

Earwigs nested freely above ground in paper, under the artificial conditions of the outdoor cages.

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